

"Express Mail Label No.": EV330463230US

Date of Deposit: February 9, 2004

APPLICATION FOR LETTERS PATENT  
OF THE UNITED STATES

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TITLE OF INVENTION: BI-DIRECTIONAL ELECTRIC MOTOR WITH  
ENDPLAY STRUCTURE

TO WHOM IT MAY CONCERN, THE FOLLOWING IS  
A SPECIFICATION OF THE AFORESAID INVENTION

## **BI-DIRECTIONAL ELECTRIC MOTOR WITH ENDPLAY STRUCTURE**

[0001] This application is based on U.S. Provisional Application No. 60/512,721, filed on October 20, 2003, and claims the benefit thereof for priority purposes.

[0002] FIELD OF THE INVENTION

[0003] This invention relates to controlling endplay of a shaft of a bi-directional motor and, more particularly, to a single endplay structure that can take-up a gap between the endplay structure and an end of a shaft of the motor.

[0004] BACKGROUND OF THE INVENTION

[0005] With reference to FIGS. 1-3, in conventional motors, one of a number of endplates is selected to take-up a gap between an end of a shaft 12 and the endplay pocket on gearhousing 14. As shown in FIG. 1, endplay plates 10 vary in thickness by 0.1 mm. FIG. 2 shows a 2 mm endplay plate 10 being used in a gear housing 14, while FIG. 3 show a 2.8 mm endplay plate 10 being used to take-up a gap between an end of a shaft 12 and the pocket on the gearhousing 14. Visual inspection is done to optimize the gap and the correct thickness endplay plate 10 is picked up via automation to meet the constant endplay plate gap of between 0.02-0.20 mm. Disadvantages of this configuration include the requirement of providing numerous parts (endplay plates) with different thickness. In addition, a constant process check is needed to select the optimum endplay plate 10 based on the gap between the end of the shaft 12 and endplay plate 10.

[0006] Due to using such endplay plates 10, conventional motors require an odd-shaped coverplate that requires numerous iterations to complete an interference fit between the coverplate and gear housing.

[0007] There is a need to provide a single endplay structure that can take-up a gap between the endplay structure and an end of a shaft of the motor.

[0008] SUMMMARY OF THE INVENTION

[0009] An object of the present invention is to fulfill the need referred to above. In accordance with the principles of the present invention, this objective is obtained by providing an endplay structure for controlling endplay of a shaft of a motor. The endplay structure includes a body having a generally elliptically shaped recess therein. The recess is constructed and arranged to be disposed generally adjacent to an end of the shaft. An engagement member has a generally spherical portion constructed and arranged to be received in a press-fit arrangement with the recess. The engagement member has a surface constructed and arranged to contact the end of the shaft. Whereby, when the surface of the engagement member is contacted by the end of the shaft, the spherical portion of the engagement member is press-fitted into the recess to control endplay of the shaft.

[0010] In accordance with another aspect of the invention, an electric motor includes a gearhousing having a gear and a shaft having a worm constructed and arranged to engage the gear. The gearhousing has a body including a generally elliptically shaped recess therein. The recess is disposed generally adjacent to an end of the shaft. An engagement member has a generally spherical portion constructed and arranged to be received in a press-fit arrangement with the recess. The engagement member has a surface constructed and arranged to contact the end of the shaft. Whereby, when the surface of the engagement member is contacted by the end of the shaft, the spherical portion of the engagement member is press-fitted into the recess to control endplay of the shaft.

[0011] Other objects, features and characteristics of the present invention, as well as the methods of operation and the functions of the related elements of the structure, the combination of parts and economics of manufacture will become more apparent upon consideration of the following detailed description and

appended claims with reference to the accompanying drawings, all of which form a part of this specification.

**[0012]      BRIEF DESCRIPTION OF THE DRAWINGS**

**[0013]**      The invention will be better understood from the following detailed description of the preferred embodiments thereof, taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts, in which:

**[0014]**      FIG. 1 shows a series of conventional endplay plates that vary in thickness.

**[0015]**      FIG. 2 is a view of a gear housing of a motor including a conventional 2 mm thick endplay plate adjacent to a shaft.

**[0016]**      FIG. 3 is a view of a gear housing of a motor including a conventional 2.8 mm thick endplay plate adjacent to a shaft.

**[0017]**      FIG. 4 is a top perspective view of an endplay structure provided in accordance with the invention.

**[0018]**      FIG. 5 is top perspective view of the body of the endplay structure of FIG. 4.

**[0019]**      FIG. 6 is an enlarged sectional view taken along the line 6-6 in FIG. 4 shown before insertion of an engagement member of the endplay structure.

**[0020]**      FIG. 7 is a view of FIG. 6 shown after insertion of an engagement member of the endplay structure.

**[0021]**      FIG. 8 is a side view of a gear housing of a motor employing an endplay structure of the invention.

**[0022]**      FIG. 9 is a sectional view taken along the line 9-9 of FIG. 8.

**[0023]**      DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENT

**[0024]**      With reference to FIG. 4, an endplay structure, generally indicated at 20, is shown in accordance with the invention. The endplay structure 20 includes a body 22 and an engagement member 28. The body 22 is preferably a portion of a gearhousing 34 (FIG. 9) of a motor 19. The gearhousing 34 can be considered to be part of the motor housing. The body 22 includes a generally elliptically shaped recess 26 therein disposed generally adjacent to an end of a shaft 25 of the motor. The shaft 25 includes a worm 21 constructed and arranged to engage a gear 23 (FIG. 8) disposed in the gearhousing 34.

**[0025]**      The engagement member 28 is constructed and arranged to be received in a press-fit arrangement with the recess 26. In the embodiment, the engagement member 28 has a spherical portion 30 and a contact surface 32, constructed and arranged to contact an end of the shaft 25. The contact surface 32 is defined by a concave radius surface such as, for example, a 30-millimeter radius that mates with an end 27 of the shaft 25 having a matching convex radius surface. The engagement member 28 can be a completely spherical (e.g., a round ball) since the contact between the engagement member and the convex radius of the end of the shaft 12 is point-to point contact to reduce friction.

**[0026]**      As shown in FIGS. 8 and 9, the body 22 is preferably a portion of the gearhousing 34 of a motor. However, the body 22 can be a separate part that is mounted to the gearhousing generally adjacent to the shaft 25.

**[0027]**      In the embodiment and as shown best in FIG. 5, upstanding ribs 36 forming an X shape extend from the bottom of the recess 26 defining a stop, the function of which will be explained below.

**[0028]**      The engagement member 28 is contacted due to the thrust force of the armature shaft 25 to insert the spherical portion 30 into the recess 26 to control endplay of the shaft 25. When this occurs, the spherical portion 30 of the engagement member 28 deforms the ribs 36 which define a dead stop for movement of the

spherical portion 30 in the vertical direction. The combination of the elliptical-shaped recess 26 and the spherical portion 30 provides an optimum configuration for an interference fit.

[0029] FIG. 6 shows the engagement member 28 located with respect to the recess 26 before complete insertion therein. The interference fit of the engagement member 28 with recess 26 can take-up a gap up to about 0.8 mm in the vertical direction. FIG. 7 shows the same engagement member after insertion into the recess 26.

[0030] With the endplay structure 20, one assembly is used instead of picking one of a plurality of conventional endplay plates. The endplay structure 20 thus reduces assembly time and tooling costs.

[0031] The endplay structure 20 can be used in any bi-directional motor.

[0032] The foregoing preferred embodiments have been shown and described for the purposes of illustrating the structural and functional principles of the present invention, as well as illustrating the methods of employing the preferred embodiments and are subject to change without departing from such principles. Therefore, this invention includes all modifications encompassed within the spirit of the following claims.